Space Weather Technical Forecast

Issued on Friday 29 November 2024 at 13:29 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Low to Moderate Activity expected. CME arrival 29 November with potential for G1/Minor Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low during the past 24 hours, with only C-class activity observed. There are now eight active regions currently on the Earth-facing disc with AR3908 decaying to plage. The largest of these remain AR3905 and AR3906 in the southwest, with some interaction likely between the two regions, however they have remained relatively inactive. A new region emerging onto the southeast limb has been numbered as AR3912, and may be one region or two separate regions - for the time being it is classified as one region but this may change as it moves into a clearer viewing angle. The remaining regions are generally smaller and simpler, with no sign of notable growth or development.

A partial filament eruption was observed from the southeast quadrant early on 28 November. The accompanying CME has been analysed, and while most of the material misses Earth there is a chance of a slight impact on 02 December.

Solar Wind / Geomagnetic Activity: Solar winds, measured by ACE and DSCOVR at L1, started at background levels generally around 350km/s but increased to a peak of around 450km/s following the CME arrival. Density started around or below average, but reached a peak of 13ppcc at 29/0433UTC due to a CME arrival. Total magnetic field strength increased from weak to moderate levels, reaching moderate levels due to the arrival of the CME at 29/0207UTC, briefly peaking at a strong level of 17nT at 29/0324UTC before easing to moderate levels. The north-south component Bz, initially varied weakly, but reached moderate levels, with a negative peak of -9nT at 29/0607UTC, although it has been mainly weakly positive. Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet throughout.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background levels. The associated 24-hour fluence remained well below the Active threshold. The integrated flux observed at 29/0000 UTC was 1.32e6 total pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with a chance of isolated M-class flares, and a slight chance of X-class flares.

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Solar Wind / Geomagnetic Activity: A CME which left the Sun on 25 November arrived on early on 29 November and is currently affecting the Earth. A further CME is forecast to arrive on 02 December. This second CME is currently forecast to glance the Earth, giving limited impacts. Otherwise mainly background solar winds are expected with coronal hole 96 forecast to be a weak feature, producing slow speeds. CME enhancements are expected to ease later today with Quiet to Unsettled (Kp 1-3) conditions following for the remainder of the forecast period, although there is a chance of the glancing blow CME arrival through 02 December temporarily increasing activity to Unsettled, with a slight chance of Active intervals..

Energetic Particles / Solar Radiation: High energy protons are expected to persist at background levels but with a slight chance of rising in response to any notable flares. High energy electron flux is expected to persist at mainly background levels with the associated 24 hour fluence remaining below the Active threshold.

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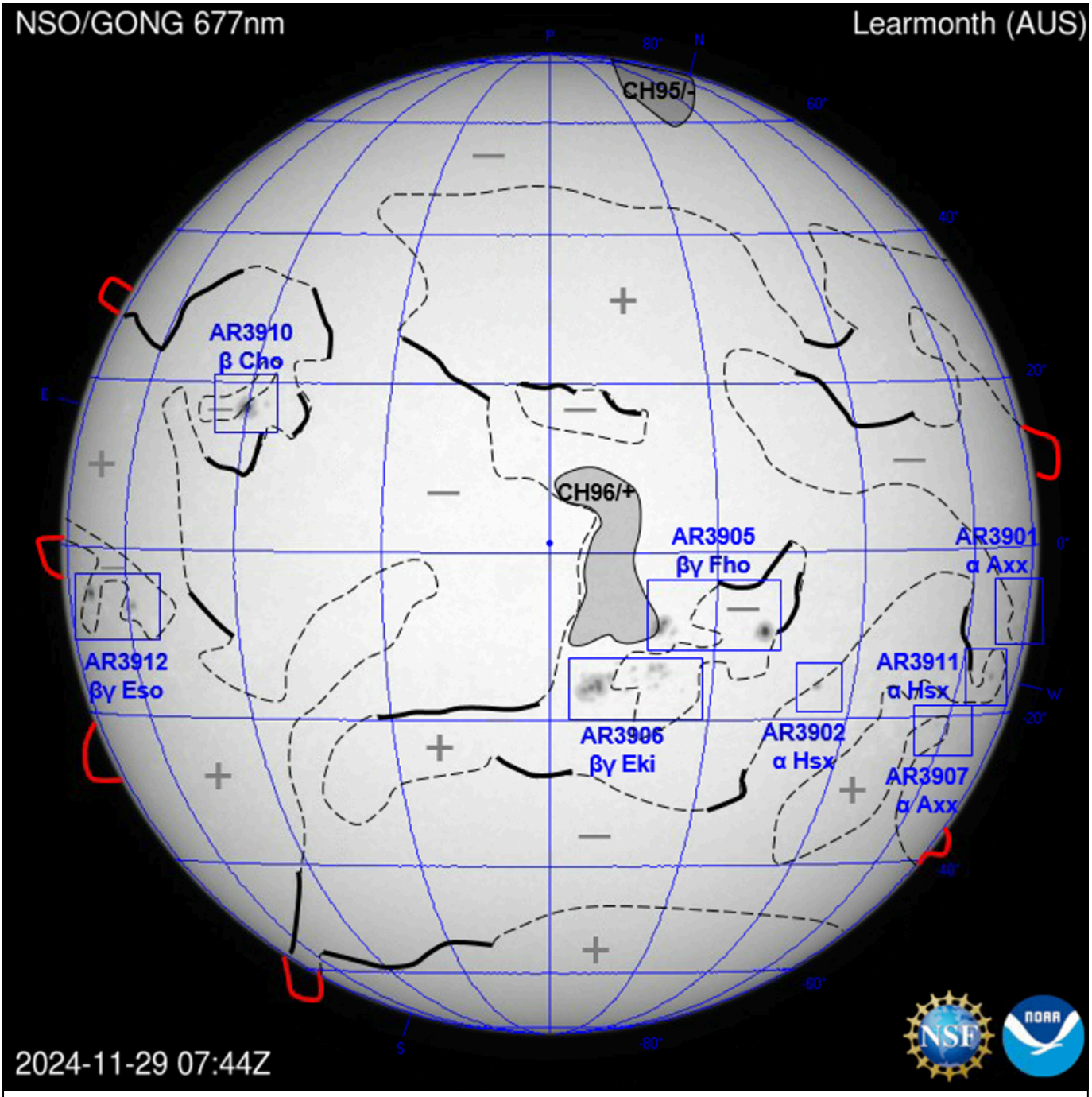
Figure 1: Solar Synoptic Map at 29/0744UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are a couple of CMEs in the forecast. The most notable is from the filament eruption around 25/2030 UTC which appears to have reached Earth early on 29 November, resulting in slightly elevated solar winds. Due to largely positive Bz this has had little impact on the geomagnetic activity. The second CME, due to a filament eruption from the southeast disc around 27/1900 UTC, has now been analysed. This is slow and mostly travelling below Earth's orbit, but may give a glance at the end of this period, on 02 Dec. However, it is likely to be quite weak by that time. While a number of other CMEs have been observed on previous days these are either missing Earth, or are narrow, slow and expected to give minimal impacts given their trajectory.

Coronal hole 96 is currently located in the centre disc and any high speed stream in association is forecast to be rather weak with any connection in coming days not expected to significantly increase the solar winds.

Initially Quiet (Kp 0-2) geomagnetic activity is likely to increase to Active with a slight chance of G1/Minor Storms (Kp 4-5) for a while today, if any prolonged negative (southward) orientated north-south component of the IMF is observed with any magnetic cloud that follows the CME arrival. CME enhancements then are expected ease later today with Quiet to Unsettled (Kp 1-3) conditions following for the remainder of the forecast period. There is a slight chance of a glancing blow CME arrival through 02 December temporarily increasing activity to Unsettled to Active (Kp 3-4).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	10	1	20
Strong	G3	No	1	1	1	0
Severe	G4	No	1	1	1	0
Extreme	G5	No	1	1	1	0

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
28/11/2024 04:28	Partial	Filament	SE	390	02/12/2024 12:00 UTC	Low confidence glancing blow.

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Figure 2: Solar wind parameters observed at L1, clearly showing the arrival of the CME from 25 November.

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Radio Blackouts - X-Ray Flares

Low to Moderate activity is expected with a chance of isolated M-class flares, and a slight chance of X-class flares.

There are eight active regions currently on the Earth-facing disc, with AR3908 no longer visible. The largest of these remains AR3905 and AR3906 in the southwest, with some interaction likely between the two regions. AR3905 and AR3906 are the the most magnetically complex region on the disc, however they have remained relatively inactive. Also of note is AR3910 in the northeast, which historically gave a M9 flare when behind the northeast limb, although since rotating onto the disc has shown little flare activity. AR3912 emerging onto the southeast limb may be one region or two separate regions - for the time being it is classified as one region but this may change as it moves into a clearer viewing angle. The other regions are generally smaller and simpler. None of the active regions on the visible disc showed any notable growth or development. Assessment of sunspot regions is currently more difficult than usual with limited imagery due to the fact that SDO data is down.

During the forecast period new or returning regions are expected to rotate onto the visible disc, therefore the probabilities of significant flares may increase.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	40	40	40	40
Very Active	R3-R5 (X Class)	No	5	5	5	5

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Solar Radiation Storms (High Energy Protons)

GOES-18 Proton flux is at background levels. As AR3905 and AR3906 are two most magnetically active regions continue to rotate into the western hemisphere, increasing their potential connectivity, the chance of solar radiation Storms increases. That being said, these regions have not shown much flare activity in the last 24 hours resulting in only a slight chance of observable high energy protons being ejected.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES-16 is at background levels, with only a weak coronal hole present on the disc with no significant enhancements currently anticipated. Solar winds are generally sitting at around 420km/s as a result of a slow CME that arrived early on 29 November and has had little impact on the electron flux levels at GEO. A potential glancing blow from a CME that left the sun on the 27 November is expected to arrive on 02 December, this may see electron flux levels become suppressed as the Van Allen belt compresses before expanding again after the forecast period.

The associated 24 hr fluence is expected to persist below Active, with MOSWOC REFM currently providing good guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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